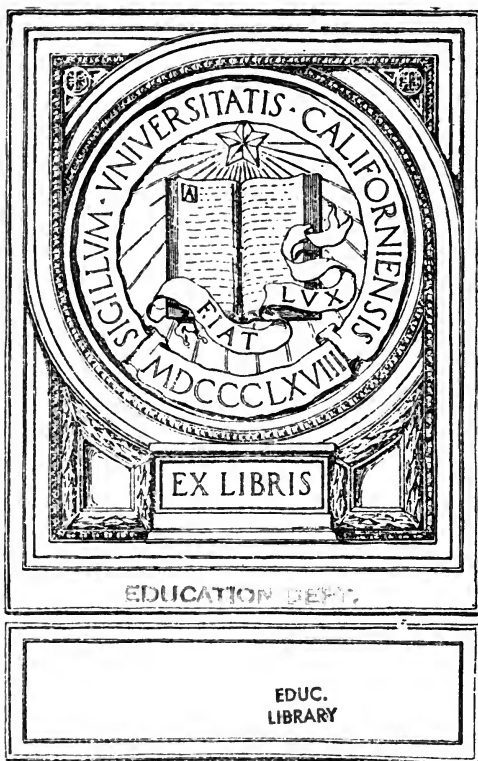


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## VIA. IN PUBLIC HIGH SCHOOLS SHOULD AGRICULTURE BE TAUGHT AS AGRICULTURE OR AS APPLIED SCIENCE?

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In arriving at an answer to the question as to whether agriculture should be taught as agriculture or as applied science two assumptions are imposed: first, that agriculture is teachable as such, and second, that it is also teachable as something else, i.e., as applied science. One's mental equipment and mental attitude toward both the subject and what it means to teach will influence his answer. These points of view are suggested as a basis for the discussion which follows. What is the probable attitude of the practical farmer without scientific training? What is the probable attitude of one trained in science without practical experience in the various arts of agriculture? What is the attitude of the learner who has had some practical experience in farming? What is the attitude of the learner who has had no experience in farm arts? The teaching of agriculture must mean something different to each of these persons.

If the practical farmer were asked to give his idea of what it means to teach agriculture to a class of high-school boys, his answer would probably be reducible to some such formula as this: "Teach the boys how to do the various things needful for carrying on the farm operations." If the farm is devoted to crop raising, these operations would be largely confined to the arts of tillage, planting, harvesting, storage, and marketing. It would also include, more or less incidentally, the care and handling of horses and the use of tools and machinery. If, however, the farm were primarily devoted to stock raising, the relative importance of the crop-raising arts and animal husbandry would be reversed. The emphasis would tend to be placed on the animal aspect, while raising crops would become incidental. In either case the farmer-teacher would place the greater emphasis upon the art of doing things. This

seems inevitable from the nature of his training. The more skilful he is himself, the more prominent would become the art aspect of his instruction. The student under such influence would easily become a trained operative in agriculture, rather than an educated agriculturist. The instruction would be direct, immediate, practical, and narrow, because of the circumscribed outlook and limited insight of the teacher.

If the same question, "What does it mean to teach agriculture in a high school?" were put to a man trained in science, the answer would in all probability tend toward the formula, "You cannot teach the application of science until you have taught the science." This attitude would postpone the study of agriculture till after a study of the sciences which are to find their application in agriculture. A foundation knowledge of scientific methods and of scientific principles would be insisted upon as a prerequisite to their application in the art of agriculture. The reason for doing things would be dominant. The laws governing the activities of Nature in the production of plants and animals would be magnified. The art of plant culture and of animal husbandry would be correspondingly minimized. The attitudes of the "farmer-teacher" and the "science-teacher" are antithetical. The "science-teacher" would become so absorbed in one or two sciences that agriculture would be touched incidentally, or as a student recently expressed it, "accidentally." The "farmer-teacher" would become so intent upon agriculture that he would lose sight of the underlying sciences. He could not see botany for so many vegetables, nor zoölogy for so many animals, nor chemistry for so much manure, nor physics for so much tillage. The "science-teacher" would be as constantly losing sight of the apple in pomology, the horse or cow in zoölogy, the fertilizer in chemistry, and soil drainage in physics. In very truth, the teacher of agriculture must be a man of perfect balance.

What of the student? One type of student brings to the study of agriculture a body of knowledge which we call practical experience. If the experience (practice) has been good the knowledge is valuable. If the practice has been bad the knowledge gained by it is injurious, because of the tendency of acquired habits to stay fixed, whether they are habits of thinking or habits of action. A person in this state of mind will approach the study of agriculture prejudiced with the idea that the way things have been done by himself in the past is a justification for doing them the same way in the future. The superficially

reasoned-out modes of operating the arts of agriculture from the narrow range of individual experience makes the mind inert. Opposed to this mental inertia is the scientifically reasoned-out justification for doing the thing at all. The practical craftsman justifies the art by the mode of operating it; the scientific operator, by the reason for the operation. This is the point at which theory and practice often come into conflict. And there is nothing which damages a theory so much as its inability to work.

This conflict between theory and practice is inevitable. It has two reasons for occasionally happening. One lies in the domain of each of the parties to this age-long controversy. Theory, on the one hand, is only a way of expressing in general terms one's idea about a group of facts or the reasons for a course of action. The idea, or conclusion, or generalization may be based upon too small a number of factors, or by giving undue weight to some factors and underestimating or ignoring others. On the other hand, practice is only the customary way of doing things. The method finds its chief justification in tradition. Its chances for being in error lie in the fact that the inception and continuance of a given practice often rest upon too narrow a range of experience. The more completely one justifies his practice by his individual experience alone, the less plastic is his mind in the presence of a disturbing theory, however well fortified the theory may be by scientific experimentation.

What of the person who comes to the study of agriculture unskilled in its arts and ignorant of the fact that, as a mode of life, it is in any way related to science? This state of mind is the virgin soil for exploitation by both the misnamed practical man and the much abused theoretical man. Here each congratulates himself that he has before him a clean slate on which he may write at will. One rejoices that here is a student innocent of the habits of a faulty practice; the other, that the student is unprejudiced by false theories.

The ideas in the foregoing suggestions seem to stand at the threshold of the discussion of the question as to whether agriculture should be taught as agriculture or as applied science. Taking the question at its face value as thus stated, the answer is easy. In fact, it is too easy for safety. A brief argument may be formulated in favor of teaching it as "applied science" as follows: "Agriculture is applied science, therefore it can only be taught as applied science." This mode of answering the

question is quite satisfactory to some minds. It fails short of being entirely satisfactory because it ignores two or three important considerations. These may be stated in the form of questions.

1. What are the motives for studying a science?
2. What are the motives for studying agriculture?
3. When is a science applied?

One other consideration must be taken into account whether one is conscious of it or not. That is, what function is the course of instruction supposed to perform for the pupil of high-school age?

First, as to the motives for the study of science. In these days science has reached so great a development in so many directions that it has in some of its phases become universal as a school study. Science does not get so much of the school time devoted to it as the languages do, but some aspect of it is taught in practically all schools. Its universality as a school subject seems to justify its claim for having educational values. Science must have a high degree of mental sustenance to have become so universal. What these mental values are need not be dwelt on here. It is enough to say that many pursue science not for the sake of any use they expect to put it to, but for the pleasure its possession gives them in their leisure and the insight it gives into the mysteries of the world of Nature about them in their daily work. In other words, science as a study has justified itself as a cultural and humanizing study of the highest order.

Correlative with this, science has its utilitarian aspect. Whatever may be claimed for it in giving the mind freedom from prejudice, and adding to one's joy of living, science will always remain a most practical study. Its practicalness lies in its application to things that are seldom thought of as being scientific in themselves. This is especially true of the theme in hand, namely, agriculture. Agriculture, which has been carried on so many generations by men untrained in science, is the latest of the great human vocations to benefit by the message science has to offer for man's welfare. The fact that the arts of tillage and husbandry are so simple as arts discourages the attainment of a high degree of skill. The application of the principles of science or of scientific method to an occupation so wanting in skill has always met resistance. This resistance seems to grow out of the fact that the workman unschooled in the science of his craft regards his work as a thing by itself and especially as a thing apart from science.

Science in the broad sense of the term has a greater message for agriculture than for any other single human industry. To put it a little more accurately, the various sciences have a multitude of messages for the numerous arts that are included under the word agriculture. There is hardly a branch of learning included in the term science which does not stand ready with a helpful message for the advancement of agriculture. Physics in its application to tillage, chemistry in the analysis of fertilizers and animal nutrition, biology in the exemplification of the laws of life, meteorology in its seasonal control of the year's succession of activities, and geology with its productive elements, the basis of soil-study as well as of plant production, all contribute to the upbuilding of a scientific agriculture.

To weigh these different bodies of scientific knowledge and to give to each its proportionate share in the advancement of agriculture requires a mind of unusual grasp.

To contend that even the simplest elements of each of these sciences should be studied with a view to their use as applied sciences afterward would preclude the possibility of the study of agriculture in any form during the high-school period. When viewed from the standpoint of the sciences involved in it, the teaching as well as the study of agriculture becomes the most complicated educational problem the public schools have ever undertaken to master.

Instruction in agriculture has two distinct phases. One involves the process of learning the art of doing things connected with the field, the garden, the barn and feed yard, the orchard, the meadow, the wood lot, and the toolhouse. The other phase of agricultural instruction relates to the sciences on which these several arts depend for their explanation. Art and science instead of being opposed, are more intimately connected in the study of agriculture than in any other subject now offered in the schools, unless it is language. The vitality of language as a school study through the centuries is due to the intimate blending of the two arts of speaking and writing with the two sciences of grammar and logic. When we once become conscious of this indissoluble tie between the arts of communication and the sciences of human thinking, no school reform will ever lay violent hands on grammar and logic.

Agriculture is much more complex. Instead of embracing only two, it has a large group of arts. Instead of being explained by only two sciences, agriculture lays tribute on nearly every science known to man.

And when the teacher of either agriculture or of science once becomes conscious of this ganglionic tie between the agricultural arts and all of the sciences he will teach science less "for the sake of science" and more "for the service of man." Now, the knowledge embraced within the domain of a given science has, in most cases, been so well systematized that a serial group of lessons may be arranged for orderly school work with very little trouble. One lesson follows another in causal or sequential order because of the relation of their subject-matter one to another. Progress is in the nature of motion in a straight line. Lessons in agriculture have little if any logical order so far as being dependent upon each other, in a causal way. It is on this account that lessons in plant culture may begin with the fruit, the roots, or the stem as is convenient. In case the fruit is taken as a starting-point the succeeding lessons, instead of running in a straight line like a series of causes and effects, or a group of closely related sequences, represent a group of sciences with the first lesson as a center of radiations. These sciences may have fairly well-defined lines separating them from each other, but the lesson on the fruit of a given plant is inseparable from either of them. It is an undivided part of each science. And the series of lessons on the fruit must go from science to science until the circuit is complete. Take an example:

The meagerest sort of a lesson on the apple would include such features as variety, form, color, size, and uses. But its variety is identical with so much of its botany; its form is involved in geometric mathematics; its color is a matter of physics, chemistry, and meteorology, and possibly of geology; its size is due in part to variety, which is botanical, in part to climate, which is meteorology, in part to altitude and latitude, which are geographical, in part to nourishment, which is physiologicobotanical; its uses first as food, second as an article of commerce, third as a source of power in the form of alcohol, identify the study of the apple with the sciences of domestic economy, economics, and political economy. From this it is plain that a lesson on the apple merely as a fruit, instead of being the beginning of a series of lessons following one after another in a dependent order, becomes the center for progress in the form of a spiral rather than of a straight line. The apple is the converging point for seven or eight well-defined sciences. And the study of the apple that confines itself to the most obvious features of it, i.e., variety, form, color, size, and uses, must cross-section each of the seven

or eight sciences. Each science in turn gives its message toward the explanation of the apple.

The apple is serving a double rôle in this illustration—it is both a center for the convergence of a group of sciences and at the same time a center of radiation into a surrounding group of sciences. And the question may now be put, as to whether the apple should be studied as a means of introducing a student to the sciences, or whether the sciences should be studied as a means of understanding the apple.

The field from which similar illustrations might be drawn is as wide as the whole field of agriculture. Examples may be found in animal life, in the garden, the forest, and in the field. Whatever object is taken, whether an apple, a potato, an ear of corn, a hen, a horse, or a forest nut, the same group of sciences must be looked to for principles of explanation and for guides to conduct in dealing with the object. These objects of study are tied up with human interest. This is what makes them agricultural. Science for science's sake is unrelated to human interests. Botany as such never touches man. Zoölogy as such only touches man as an animal, and as a science is unrelated to human interests until it deals with horses and hogs and hens, not because they are animals but because they are man-nurtured animals. Botany allies itself with human interests only when it deals with plants as they are related to human welfare. The human-interest aspect of the physical and biological sciences is what makes certain substances like soil, water, and air, and a few plants and animals, agricultural. To teach these things apart from their human interest makes them simply objects of science and non-agricultural. It would, therefore, appear that from the standpoint of the close relation of the farm arts to the sciences, or from the standpoint of human interest, agriculture should be taught as agriculture and not as an applied science.

## VIB. IN THE PUBLIC HIGH SCHOOLS AGRICULTURE SHOULD BE TAUGHT AS AGRICULTURE, NOT AS APPLIED SCIENCE

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A very large part of our agricultural instruction may be combined with other sciences and will serve to enrich these studies. I believe that agricultural illustrations will almost revolutionize the teaching of science, which is in danger of becoming too academic. So soon as we get a science well systematized with definite sets of laboratory exercises, which we feel are fixed for all time, we have lost one of the most useful features about science, that is, that it studies the earth and the civilization that surrounds us—conditions that are ever changing.

While teaching capillarity in physics, the soil offers a most valuable illustration. While teaching friction, such questions as the relative draft of riding and walking plows may be cited. A well-constructed riding plow will carry a man and draw easier than will a walking plow, because a third of the draft of the walking plow is due to friction on the bottom of the furrow, whereas with the riding plow, the friction is placed on the axle and the axle is greased. Another illustration might be given of the reason why placing the double-tree below the tongue will enable a team to pull a heavier load than if the double-tree is high, as in the case of carriages. The first thing that gives way when a horse fails to pull a load is the feet. The horse cannot stick to the ground, but if hitched low a part of the load will pull down on the back, making the horse "heavier" and the friction greater, and will enable the horse to pull more. This is also one of the reasons why a draft horse should be heavy.

While teaching bookkeeping in rural high schools, farm accounts rather than operations involving some large city business should be used for at least a part of the illustrative material. Farm accounts are more complicated than are the accounts for city business. They would, therefore, better meet the objection that some people have to bookkeeping—that it does not require sufficient mental application.

I know of no better ecological illustration for the botanist than the lime requirement of plants. Alfalfa may fail for lack of lime where clover thrives; clover may fail and timothy yet thrive; timothy may fail and still redbud may grow. Similar illustrations for these and other sciences may be multiplied indefinitely.

Since agriculture is based on all the sciences, some persons have argued that it can best be taught by having the principles presented in the separate sciences, as illustrated above, rather than by having a new subject. This argument may sound logical, but it is utterly impracticable. Our textbooks of science are not written by persons who know much about agriculture. As soon as they go beyond a few very general illustrations they are more likely to emphasize some popular fallacy than to give real scientific principles. Agriculture is a new and rapidly growing science. To keep all the textbooks up to date would be an impossible task. It will be difficult enough to keep the textbooks on agriculture up to date without having to revise the agriculture in the science books every year. A good textbook of chemistry is good the world over. It ought to include illustrations from agriculture as well as from all other fields of human experience to make it good chemistry, but such illustrations must be very general. Agriculture is more local in its pedagogy. The cotton plant and the apple may illustrate a certain point equally well, but in teaching agriculture we will want to use the illustration that fits the region.

Our teachers of science are not likely ever to know enough about agriculture to be able to go very far with the introduction of agriculture into the sciences. Many good chemistry teachers come from the cities and villages and know nothing about agriculture. No teacher is likely to be of much use in teaching agriculture who has not had a good farm experience as well as a good course in this subject.

For a generation the agricultural colleges tried to have agriculture taught by botanists, chemists, etc., but not until they added professors of soils, crops, and cows were their agricultural teachings of much value to prospective farmers. The high schools will save time if they profit by these many years of experience. But there is another reason why agriculture must be a separate subject, if very much is to be accomplished. Agriculture is a science in itself—a science in part founded on other sciences, in part independent, just like all sciences. It is certainly as much an independent science as is the science of medicine. We

should not think of expecting the teachers of botany, zoölogy, chemistry, and physics to train physicians. No matter how many medical illustrations these teachers may use, we must always have separate departments and separate instruction that will correlate all these sciences into a single unit—the science of medicine. Similarly we must have all the sciences correlated into the unit—agriculture.

Let us take a single illustration. How would the teaching of crop rotation proceed if there were no separate subject of agriculture? Crops are rotated:

1. To control weeds.
2. To control insects.
3. To control fungi.
4. To keep up the humus supply.
5. To secure the benefits of growing grasses and legumes on each field.
6. For convenience in working.
7. For control of toxic substances.

Possibly the botany teacher might mention weeds, fungi, legumes, and grasses in this connection, and might even discuss toxic substances. The teacher of zoölogy might mention crop rotation as a means of controlling insects. Certainly no science teacher would consider the convenience in working that comes from growing crops in a certain order, yet this is the chief reason that leads farmers to rotate crops. But if all these points were mentioned at various times and in this disconnected way, it would not teach crop rotation.

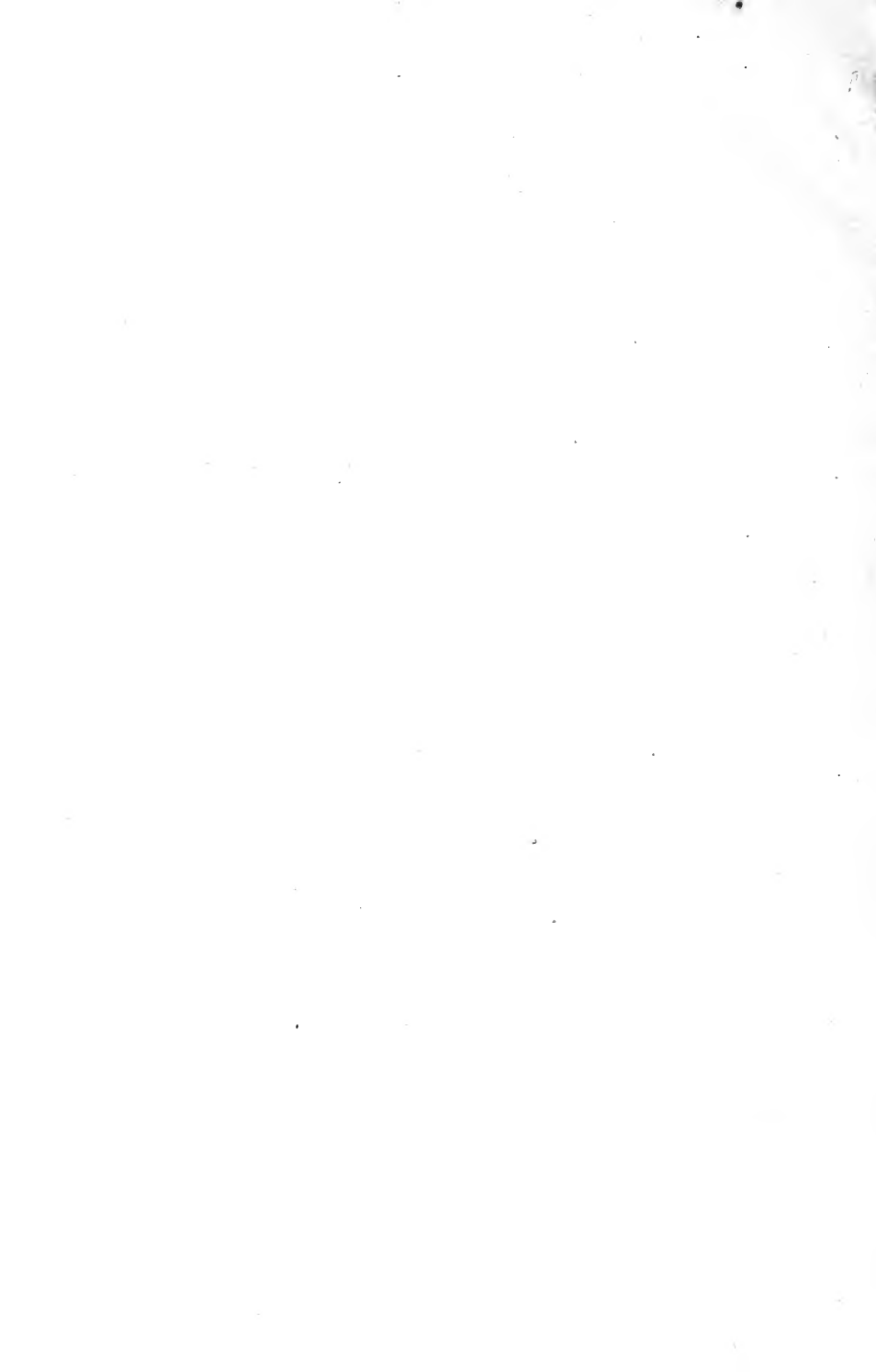
More important than the reasons for crop rotation is the planning of cropping systems adapted to particular farms. This does not belong in any of the sciences except the science of agriculture.

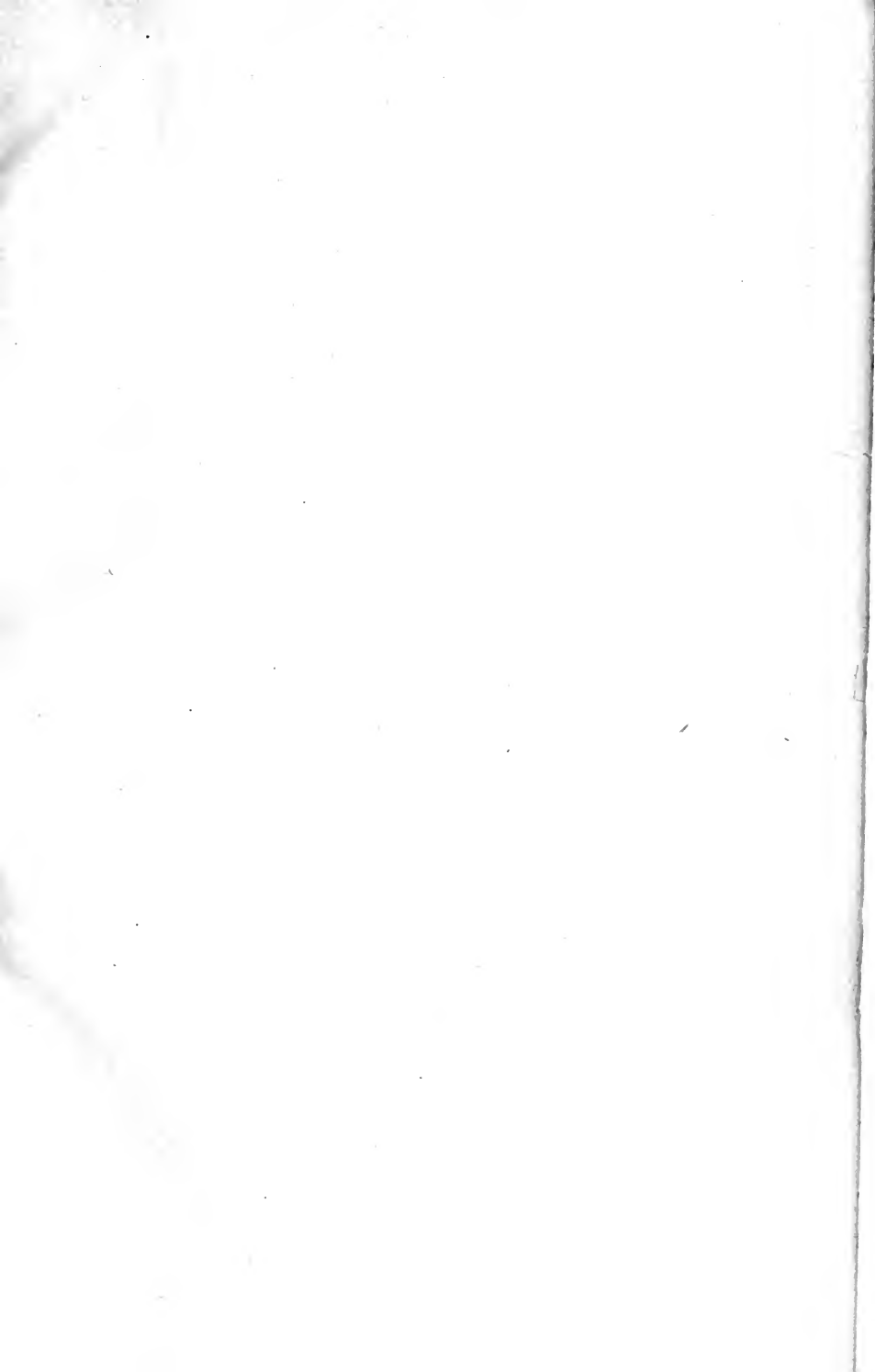
Perhaps no error is more prevalent than the idea that agriculture is nothing but the application of other sciences. Even some agricultural colleges still fail to grasp the idea that agriculture is itself a science. Probably half of the best teaching of agriculture is not the application of any science except the science of agriculture. The laying of a tile drain is not physics. The training of a colt is not zoölogy. The grading and packing of apples is not botany.

The selection of a farm is one of the most important decisions in the life of a farmer; such a selection should be based on scientific principles. The decision as to the best type of farming for the region, the stocking

and equipping of the place, the cropping system to be followed, are of the utmost importance to the farmer. But to what science do these things belong except the science of agriculture? A mistake in one of these cannot be overcome by any knowledge of life histories of insects or ideas on how plants grow.

Any school course that pretends to prepare for farming must teach the usual sciences and ought to include in these as many agricultural illustrations as possible, but to try to give agricultural training without agriculture as a separate subject is like *Hamlet* with Hamlet left out.





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